

OHLMACHER (A.P.)

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With Large Classes of Medical Students.

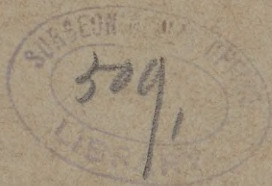
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LABORATORY INSTRUCTION IN ELEMENTARY COMPARATIVE ANATOMY AND EMBRYOLOGY

WITH LARGE CLASSES OF MEDICAL STUDENTS.*

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*(Prepared for the Section in Anatomy of the First Pan-American
Medical Congress.)*

DURING the past two years I have been engaged in teaching elementary comparative anatomy and elementary embryology to large classes of medical students. In the institution with which I have been connected laboratory instruction in comparative anatomy and embryology has been incorporated into the course of study as two distinct major

* By a mistake this paper was miscarried and did not obtain a reading at the congress. With the paper were several hundred drawings, made by members of the various classes, which were to be exhibited when the paper was read. The illustrations which accompany this article are photographic reproductions of a few of the drawings, and represent a fair average of the character of the work displayed in the whole set returned by the students. The original drawings were on sheets of paper $11 \times 8\frac{1}{2}$ inches, and are of course reduced in reproduction. It must be remembered that, with all their advantages, the photo-engravings can not do justice to the original drawings.

branches, and each student in the first and second years' course has been expected to pursue the work unless conditioned on account of previous biological training. As a consequence, the classes in these laboratory exercises were large, and my position as a teacher of a compulsory laboratory course in comparative anatomy and embryology in a medical college in the United States, at least, has been a unique one. In the belief that my experience may be of interest to other teachers, I am prompted to bring this subject to your attention and to exhibit to you some samples of class work.

The management of large classes in a biological laboratory exercise involves details, many of which can only be gained by experience. In the first place must come the laboratory itself and the laboratory equipment. In the college in which I have been teaching the laboratory of comparative anatomy and the laboratory of embryology occupy two distinct floors of the laboratory building. Each laboratory room is twenty-five feet wide and one hundred and sixty feet long, and well lighted on the side. The room contains fourteen tiers of desks, each tier consisting of eight single desks arranged in two rows of four each, back to back. It will thus be seen that the laboratory of comparative anatomy, for instance, contains desk room for the accommodation of one hundred and twelve students at a single laboratory exercise. The desks are made of whitewood with a plain top and of the proper height to permit the student to work in the sitting posture. Each desk has a top surface of two feet by three feet and a half, with ample knee space below and a cupboard on the right side provided with a Yale lock and containing two drawers, in which the individual student's equipment may be readily stored. Sinks with hot and cold water supply are arranged about the laboratory convenient of access.

The equipment of the laboratory is of such a character that each student obtains and keeps in his locker all the

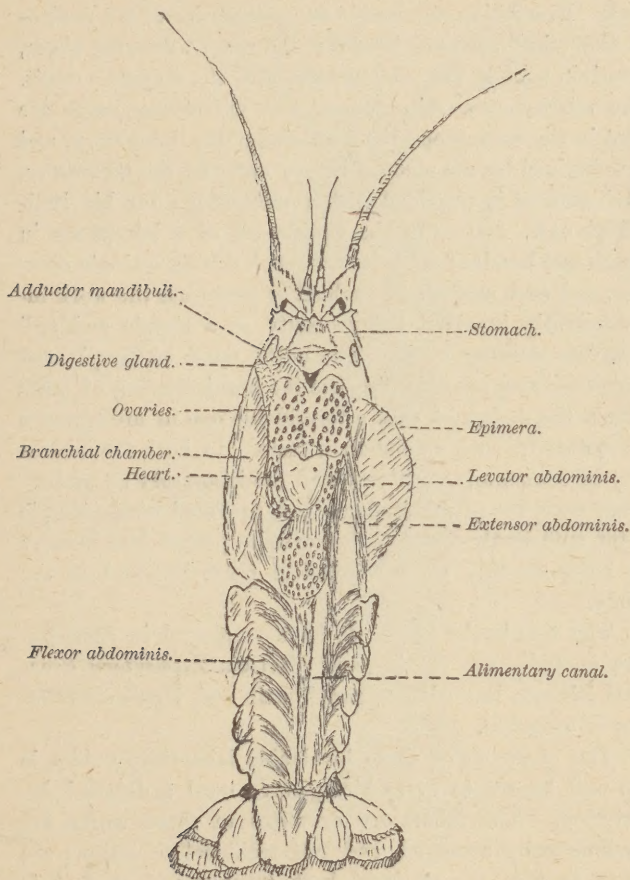


FIG. 1.—F. Weatherford.

material required throughout the course, with the exception of the microscope, microtome, and an occasional spe-

cial instrument or staining solution. This outfit is obtained at the opening of the term by the student and kept in his desk. Everything required in the prosecution of the work—as dissecting instruments, slides and covers, drawing paper, pen, ink, pencils, etc.—is furnished in the student's outfit. The microscopes, microtomes, and imbedding baths are kept in the microscope room adjoining the laboratory, and are obtained by the student before entering the laboratory. Each student is provided with a microscope for his individual use. Naturally the equipment of a laboratory in which one hundred students can work during a single exercise, and each student be enabled to prosecute the work independently, involved the necessity of a simple and still complete working outfit. The outfit must be simple and inexpensive as possible, because the multiplication of parts makes the matter of cost a formidable one in fitting out a laboratory on such an elaborate scale. In both the laboratory of comparative anatomy and the laboratory of embryology each one of our students was provided with a simple outfit, sufficiently complete, however, to permit him to carry on independently all the technical work involved in the study.

The text-books which we have employed in comparative anatomy are Huxley and Martin's *Elementary Practical Biology*, last edition, and Martin and Moale's *Dissection of a Rodent*.

The character of these invaluable laboratory guides is too well known to every biologist to need a detailed description. The laboratory exercises in these works are systematically arranged, and full technical directions are given, so that the work of both teacher and student is much lightened by following very closely the instructions outlined. The animals chosen for study during the first two courses of instruction in this department were the

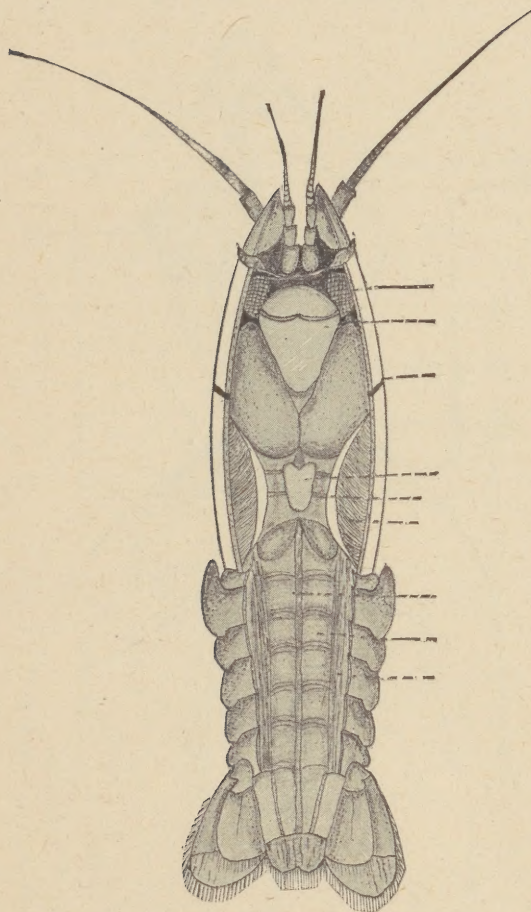


FIG. 2.—Organs of crayfish. F. E. Wynekoop.

crayfish and the frog. During the last term the animals dissected were the frog and rat. The time devoted to comparative anatomy by the first year's class was ten hours a

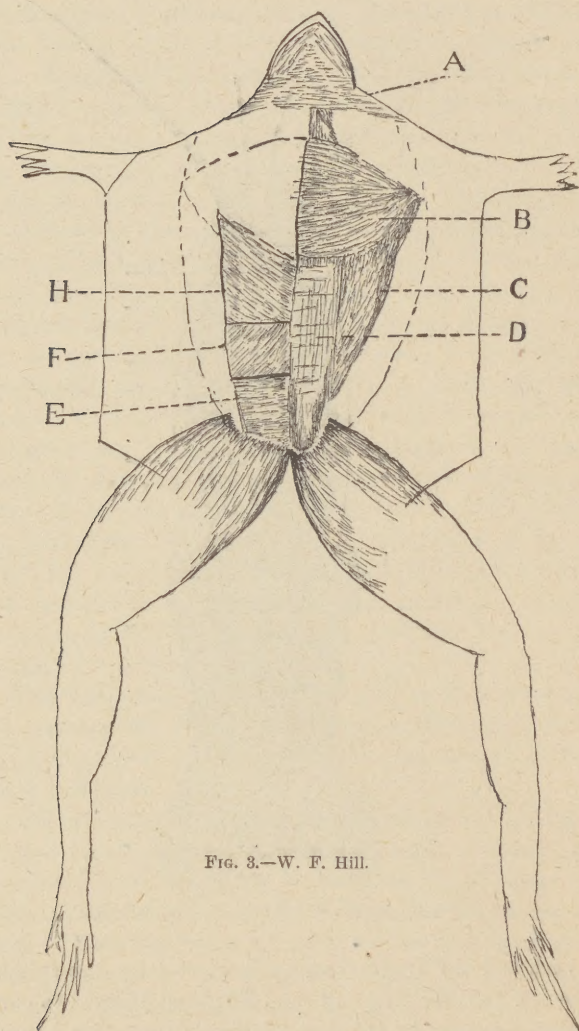


FIG. 3.—W. F. Hill.

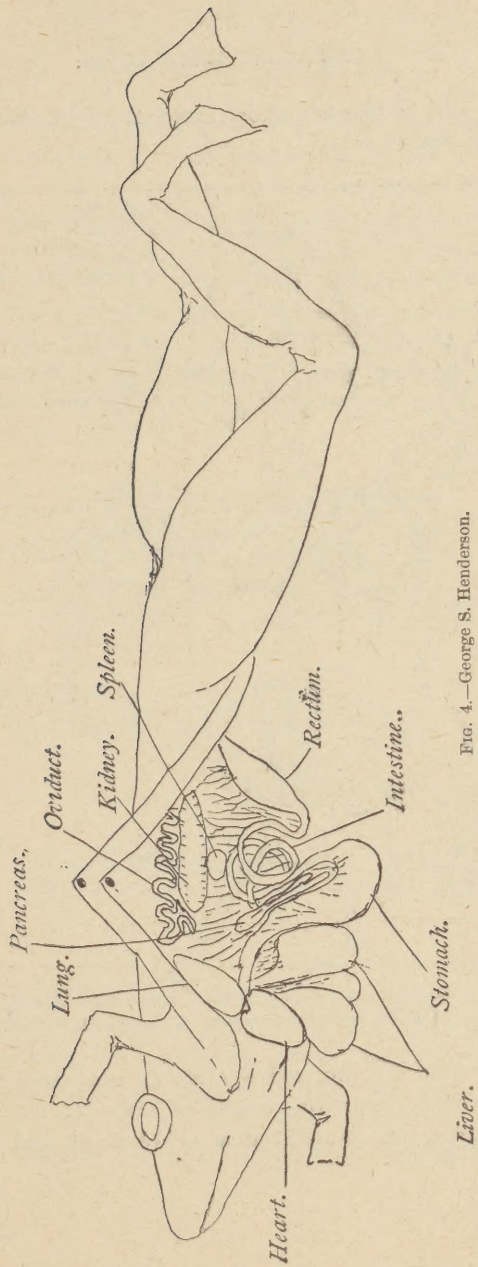


Fig. 4.—George S. Henderson.

week; that is, four laboratory exercises of two hours each and one oral exercise.

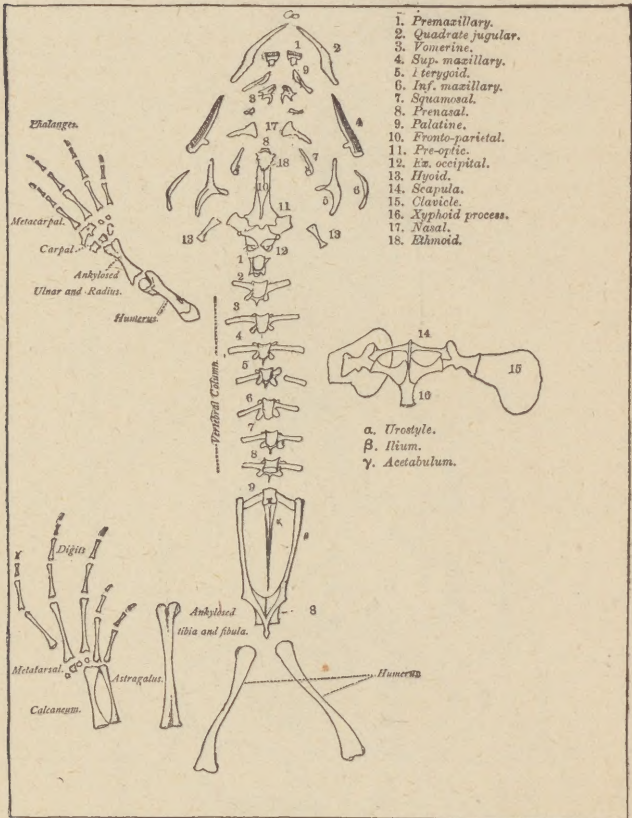


FIG. 5.—Skeleton of bullfrog. C. L. Lénard.

The class in comparative anatomy numbered twenty students during the spring course of 1891-'92, ninety students during the winter course of 1892-'93, and twelve

students during the spring course of 1892-'93. Gentlemen who had completed a biological course in any of our colleges were exempt from the work in comparative anatomy. Of the students composing our classes, five per cent. were college graduates, ten per cent. were high-school graduates, and the balance were students who had been admitted to the college on examination, or on the presentation of credentials other than school and college diplomas. In all of these classes not more than half a dozen students had ever taken previous laboratory work in any of the biological

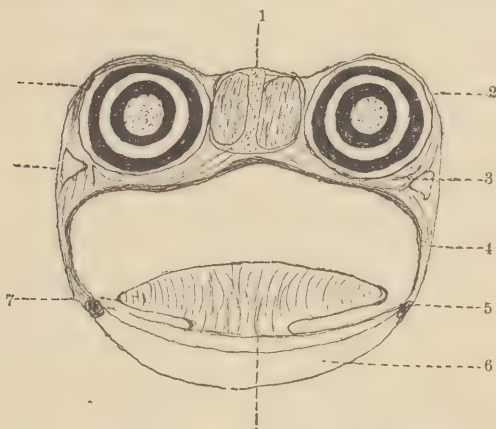


FIG. 6.—Head of frog, transverse section. Lee Weber.

1. Brain. 2. Eye. 3. Eye muscle. 4. Mouth. 5. Jaw bone. 6. Lymph space.
7. Tongue. 8. Hyoid.

sciences. In other words, the classes were untrained in laboratory methods. I believe it is pretty generally understood among teachers of biology that it is very difficult, if not impossible, to introduce a student into the work laid down in Huxley and Martin's *Biology* who has not had a previous elementary training. We did not find this to be the case, for our classes were introduced directly into

the exercises on the crayfish and frog as laid down in Huxley and Martin, and each student pursued to the most minute detail each of the dissections prescribed in the laboratory work, with the exception of the portion relating to histology and embryology. All of the preparations—as, for instance, the wet and dry skeletons, the arterial and venous injections—were made by each member of the class.

It will be recalled that the laboratory work on the crayfish, as laid down by the new edition of Huxley and Martin, occupies about fifty closely printed pages; that upon the frog about one hundred and forty pages; and the dissection of a rat, as prescribed by Martin and Moale, occupies seventy pages. It was our constant endeavor to im-



FIG. 7.—Longitudinal section, rat's brain. T. Sachs.

- 1, olfactory lobe; 2, cerebral hemisphere; 3, corpus callosum; 4, fornix; 5, corpora quadrigemina; 6, cerebellum; 7, medulla; 8, pons; 9, infundibulum; 10, pituitary body; 11, lamina terminalis; 12, tuber cinereum; 13, third ventricle; 14, iter; 15, fourth ventricle; 16, chorioid plexus.

press upon the student the desirability of a *detailed* study of the types selected, in the belief that a training of this kind was more valuable to the medical student than the cursory examination of a number of types.

Especial stress was laid upon the drawings, and we look with pride upon the work which the students have turned out in this direction. It is well known that the laboratory guides mentioned have no illustrations. Aside from this, the students were discouraged from looking for illustrated works to guide them in their drawing. I can safely assert that, among all of the students who have thus far taken the work in comparative anatomy and embryology, not more than half a dozen members of these classes possessed or referred to pictures of the objects of their drawings. While every legitimate aid, as instruction by the teachers and reference to meritorious work of other students, was given to the members of the class, copying was discouraged and individuality encouraged. The rough drawings of a given

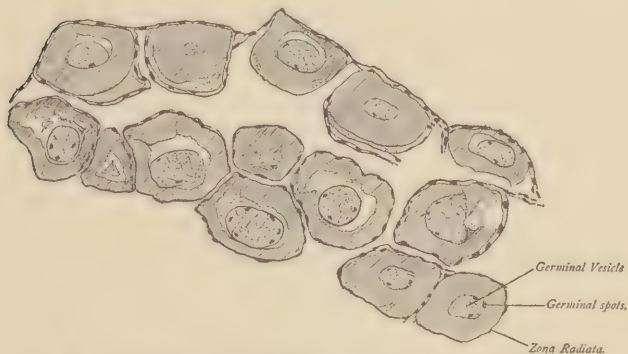


FIG. 8.—Ovary of the salamander (resting stage). H. Hartung.

object or dissection were first made in a note-book with pencil during the laboratory hour. These rough drawings were inspected by the demonstrator and directions for improvement often given. Each member of the class was provided with fifty or a hundred sheets of heavy white paper, eight inches and a half by eleven inches in dimensions, and one

heavily ruled sheet which was placed under the drawing to outline the field. A set of lithographer's pens and a bottle of India ink was also furnished in the student's outfit. The student was instructed to reproduce his note-book drawings in ink on the sheets provided, improving on the original in every possible manner.

I have the pleasure of submitting for your inspection some of the many hundreds of drawings which have been returned by the students in the laboratories of comparative anatomy and embryology during the last year. Permit me to say that these drawings represent only a fair average, no effort having been made to select the better productions. They represent two or three samples of the work of about a hundred students. Further, I would say that no member of either of the laboratory classes failed to submit a set of drawings representing his laboratory work, for the drawing was considered an essential feature in determining the grade of the laboratory work. While on the subject of drawings it may be said that we invariably noticed that the best students in the laboratory—that is, the most careful dissectors and most enthusiastic workers—made the best drawings. An examination of these drawings will give an idea of the subjects studied during the course, and of the various dissections and preparations made by the students. As a rule, the drawings were made in plain outline, the student being advised to confine himself to outline work unless especially trained in shading. It will be noticed that while the parts of a given drawing are indicated in some drawings they are omitted in others. This is because the drawings were accompanied by a set of notes, usually written on the same paper as employed in the drawings, and often the drawings were described in these notes.

I have before remarked that the animals chosen for study were the crayfish and frog for the first two classes,

and the frog and rat for the last class. We have decided upon the frog and rat as the types for study during our future courses, because of the manifest preference of our

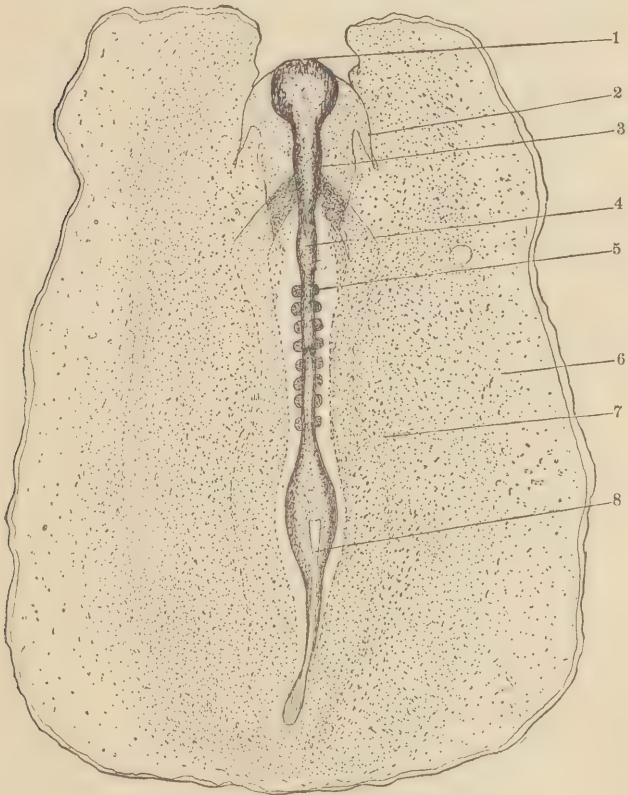


FIG. 9.—Thirty-four hours' chick. C. W. Dulin.

1. Forebrain. 2. Amniotic fold. 3. Midbrain. 4. Hindbrain. 5. Mesoblastic somite. 6. Area opaca. 7. Area pellucida. 8. Primitive streak.

students for those types which most nearly approach in structure the higher and more familiar mammals. The frog

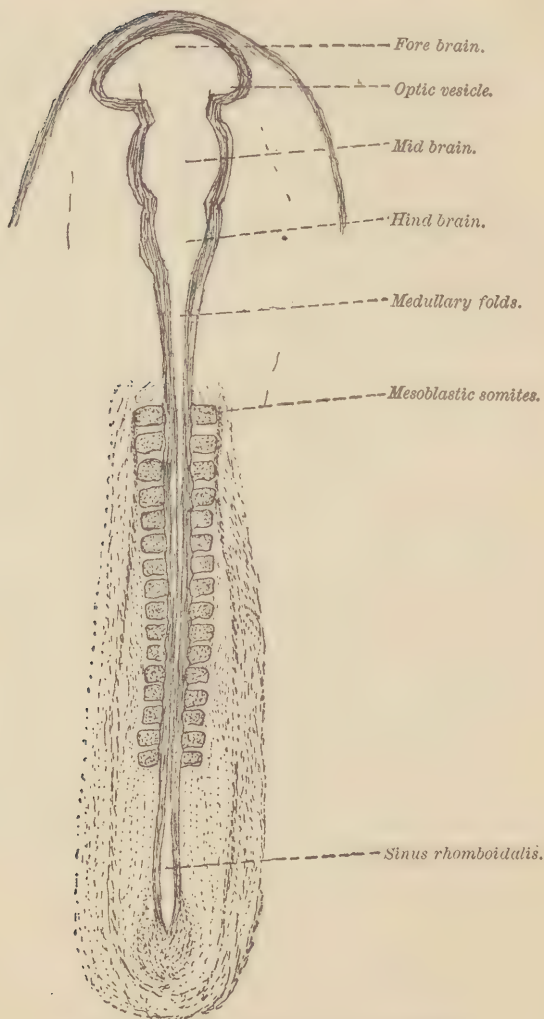


FIG. 10.—Thirty-six hours' chick. B. Feltenstein.

and rat are especially chosen for several reasons. They are abundant and easily obtained. They are small and consequently easily preserved between the laboratory hours. I am further much in favor of these smaller animals because the more delicate dissections and acute observations required in their study afford, to my mind, a more valuable discipline and a better preparation for the study of human anatomy than could be obtained by the use of larger animals. Finally, we have two most excellent laboratory guides for the study of the frog and rat.

Our object in introducing the study of the crayfish into the work was to acquaint the student with the anatomy of a typical segmented invertebrate as a means of comparison with the vertebrata. I must confess, however, that the students showed a marked dislike for their work on the crayfish and a corresponding preference for the study of the frog. This was in part due to the fact that they were

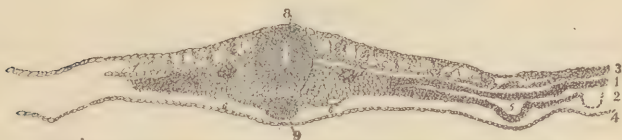


FIG. 11.—Thirty-six hours' chick, behind heart. S. J. Somberger.

studying human anatomy simultaneously with their course in comparative anatomy, and their constant endeavor seemed to be to find something in their lower animals which they could compare with their human dissection. Many of the well-intended lessons on the comparative anatomy of a typical vertebrate and invertebrate animal were therefore lost; but this was compensated for by the interest and enthusiasm displayed by the class during their work on the frog and rat.

The only addition to the regular work was attempted



FIG. 12.—Forty-eight hours' chick, behind heart. H. Wagner.

last winter, when about twenty members of the class undertook an extra month's work after having completed the regular course on the crayfish and frog. As a subject for this work I chose the comparative anatomy of three vertebrate brains, permitting the student to select three brains from the animals suggested. The animals chosen for this study were the frog, turtle, fish, snake, bird (pigeon, hen, turkey), rat, cat, dog, sheep, calf, and man. Each student obtained his own material, made his own dissections, and preserved the specimens. The work was undertaken with the greatest enthusiasm, and, considering the short time left for the study and its occurrence at the end of the college year's work, with examinations coming, I think the results were very commendable. Some of the drawings returned by these students are included in those submitted for inspection. At the completion of this work every member of the class wrote an essay on the three brains studied as a part of his final examination.

While the laboratory instruction formed the major part of the course in comparative anatomy, some didactic exercises were held, aside from the oral instruction in the laboratory. In fact, as the practical work progressed, many questions were presented to the students' minds which called for answers more elaborate than could be given in the short laboratory hour. Once every week an oral recitation was held. I say recitation, because our exercises were of a general conversational character, with none of the usual lecture element. The students were free to question the teacher in any subject which occurred to them relating to the work. In these oral exercises the constant aim was to encourage the comparative method of study, and to impress upon the student the relation of his little work to the vast field of animal morphology. Great stress also was laid on the employment of a precise biologic-

al terminology, for it is an unfortunate fact that a desirable nomenclature has not yet found its way into human

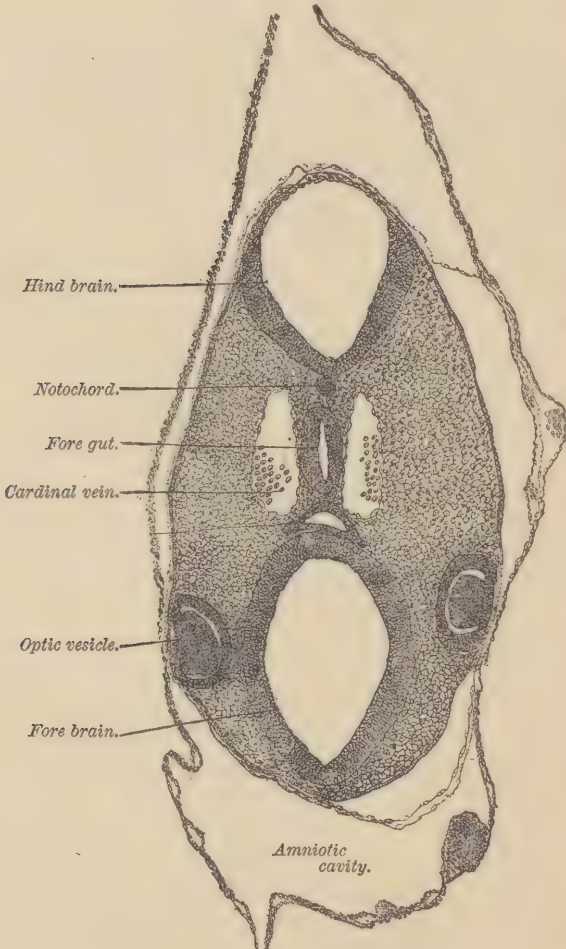


FIG. 13.—Three days' chick, head. I. B. Seagly.

anatomy. From the papers which were returned at the final examinations, it appeared that these oral exercises had not been without their effect in supplementing the laboratory studies.

The course in elementary embryology was conducted upon the same essential plan as that in comparative anatomy. There were laboratory exercises and one recitation a week. In embryology, however, the course was shorter, as only two exercises of two hours each were devoted to the laboratory work in this branch.

The first class in embryology numbered about sixty-five students who were absolutely untrained in laboratory methods, since this course was given when laboratory work was first initiated in the college, and before the new laboratories were built. The first class was divided into two sections, each section meeting but once in two weeks. The second class in embryology numbered about one hundred students, all of whom were accommodated in the new laboratory at one exercise. The third class was the spring class of the present year, numbering about thirty-five students. The second class was somewhat familiar with laboratory technique, most of the students having done some work before coming to the embryology. The last class in embryology was composed of the students who had taken the full first year's laboratory course, including comparative anatomy, during the previous term. The work of this class was particularly gratifying to me, for more work and better work was accomplished in a shorter time than with any other class, and the enthusiasm which pervaded the class, and the eagerness for more work, were more manifest than during any previous course. This demonstrated most forcibly the effects of systematic laboratory training in elementary comparative anatomy and histology, in providing the student with an independent mas-

tery of laboratory technique, and in developing in him a love of an advanced practical study.

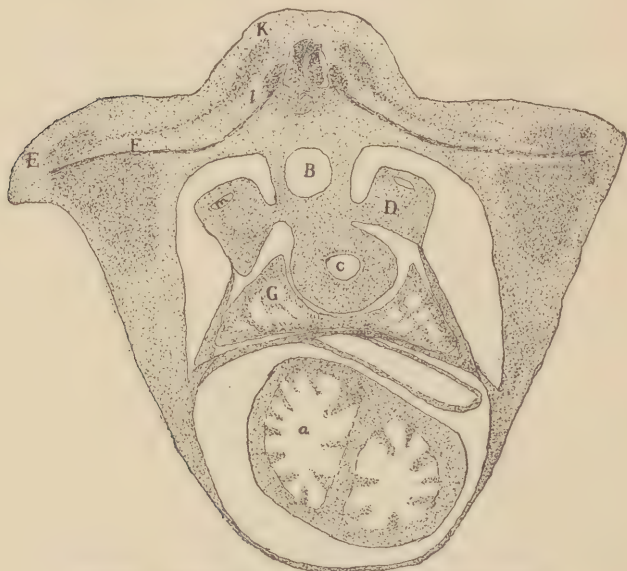


FIG. 14. —Five days' chick, through heart. Louis Dysart.

Our work in embryology was essentially limited to a study of the chick's development during the first five days of incubation. During the last course some work was done in mammalian embryology. Essentially, the exercise consisted of the practical studies as laid down in the appendix of Foster and Balfour's *Elements of Embryology*. The students were not, however, provided with this text-book, but were guided in their laboratory exercises by some written syllabi; and for a didactic study they employed any of their anatomical or physiological text-books in conjunction with the oral instruction. During the last year three most ex-

cellent text-books on embryology have been made available in our language; and I have recommended one of these three works—by Marshall, Minot, or Hertwig—to my last class as a text-book to supplement the laboratory instruction.

The student prosecuted all of the technical work in embryology. Each student studied the whole living embryo in the egg during the various typical stages of development advised by Foster and Balfour, then removed the embryo and studied it as a transparent object, and finally killed and fixed it and preserved it for future microscopical study. When the series of whole embryos had been studied, the tissue obtained by each student was stained, imbedded, cut in serial sections, and mounted. Every student in the class obtained a thorough drill in the technique of avian embryology, and made many permanent preparations for his future study. For the regular course, however, it was found advisable not to depend upon the sections cut by the students for systematic study, because many accidents in preparation occurred which would have defeated any plans in this direction. For the systematic study of sections, therefore, the class was provided with a set of uniform sections prepared by the demonstrator.

I have found it advisable, in some minor details, to depart from the order of the practical work laid down in Foster and Balfour. For instance, it was found after the first trial that the thirty-six-hours' chick was too difficult an object for introductory study by students unfamiliar with embryological technique; and, as a consequence, the lessons on the thirty-six-hours' and forty-eight-hours' chicks were unprofitable. I have found, moreover, that much of the success of a laboratory course of instruction depends upon arousing the enthusiasm and interest of the class early in the study, and that three or four unprofitable

and difficult lessons at the outset will do much to dampen the ardor of the most earnest student. To make the work interesting early in the course, and to provide the student with an object which he could readily study, I have, during the last two courses, introduced at the second lesson the embryo of the *fourth day* of incubation. The first lesson was devoted to the study of the unincubated hen's

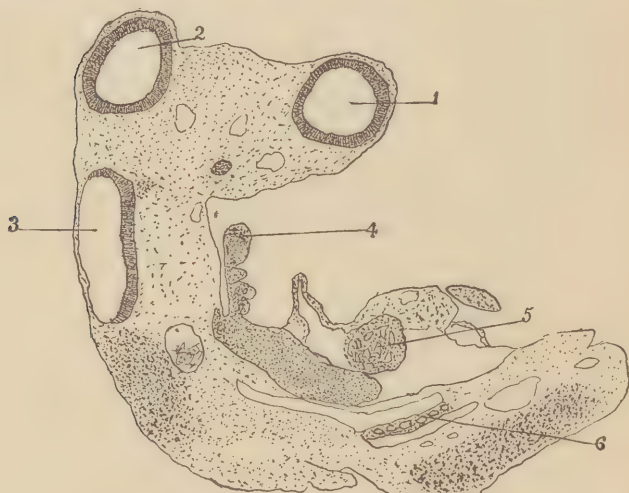


FIG. 15.—Longitudinal section, four days' chick. W. D. Leach.
1. Forebrain. 2. Midbrain. 3. Hindbrain. 4. Visceral arch. 5. Heart.
6. Kidney.

egg, in order that the student might become familiar with the parts of the egg as an introduction to further study, and also that this object might serve as a lesson on an animal ovum, directing the student's thought in the direction of a comparative study of animal ova. The four-days' whole embryo, introduced at the second lesson, proved a most attractive object to the student. The blastoderm was

of a sufficient size to permit of careful study by the unaided eye, and the embryo, with its beating heart and well-defined outline, was a very impressive object. The observations upon this embryo readily paved the way for the study of the younger chick embryos compared with this four-days' chick as a type, and the three-days', two-days', thirty-six-hours' and twenty-four-hours' embryos were introduced, one at each succeeding lesson. One lesson was devoted to a study of the development of the blood and blood vascular system. Following these lessons, several hours were devoted to practical work in cutting and mounting the embryos previously hardened by the members of the class. The study of sections succeeded the technical work, and in this study the order employed with the whole objects was reversed; that is, the younger embryos were studied first. A section behind the heart of a thirty-six-hours' chick introduced the work on sections, and this lesson acquainted the student with the embryonic layers, the neural canal, notochord, aortæ, Wolffian ducts, cleavage of the mesoblast, etc.—that is, with the fundamental structures of the embryo. Sections through the heart and head of the thirty-six-hours' chick were now introduced, and these followed by various typical sections of the two-days', three-days', four-days', and five-days' chick embryos.

The drawings were made by the members of the class in embryology in essentially the same manner as in comparative anatomy—that is, class-room sketches were reproduced in India ink. The drawings which have been submitted for your inspection represent a fair average of the work of the last two classes.

My experience in the two years of teaching these courses in a medical school has convinced me of the value of this kind of training in the medical curriculum. In fact,

it seems to me an indispensable preparation for the more applied branches of medical science; and, as an introduction to the higher laboratory courses of the medical school, I can conceive of no more profitable work than this ele-

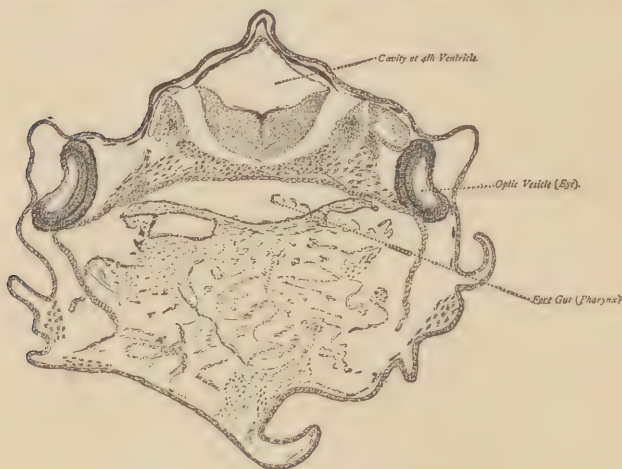


FIG. 16.—Head of tadpole. D. R. Stockley.

mentary training in biology. It is often argued that the student should have obtained his training in comparative anatomy and embryology before entering the medical school. This is certainly true; but how many of the students who apply to-day for admission to our American medical colleges have had a biological laboratory training? We are always ready and willing to condition those students who have prosecuted biological studies at any of our science schools.

As to the direct benefits to the student of such a laboratory course as I have outlined, I may mention a few which have come under my notice during the experience with the classes in the laboratory. The training in the

laboratory methods, and the instillation of that independence so essential in practical scientific study, I regard as the first result of this work. The delicate manipulations and patient endeavors required in many of the minute dissections in comparative anatomy are an invaluable discipline to the medical student. The handling of fresh tissue and the often unconscious acquaintance with many simple physiological processes are peculiar to this work on the lower animals. The methods of recording observations, both in writing and in drawing, are early acquired by the student. Scarcely second in importance to the purely technical training comes the training in biological terminology acquired by the students in these branches. It was very gratifying to find, in the various examinations, the ease with which the students had acquired and employed the precise terms of the new biology. Any one who has inspected the anatomical examination papers of the ordinary medical student must have been struck by the student's poverty in this direction.

The verdicts of my colleagues who are engaged in teaching such subjects as histology, pathology, surgical pathology, and bacteriology in the laboratory, are very much in favor of those students who have completed the course in comparative anatomy and embryology. These students enter the advanced laboratory studies with a foundation in the method of scientific work amply sufficient to take from their teachers the time-consuming task of preliminary training in technique; they enter the laboratory with the eager enthusiasm of the true scientific spirit, and their work is accordingly satisfactory. During our last spring course the class in bacteriology, under the instruction of Dr. Gehrman, was composed of the same members as my class in embryology—that is, of students who had taken a year's laboratory work in histology and com-

parative anatomy: I am informed that the work of this class in bacteriology was of the highest order, and that, while the course of study was shorter than usual, the ground covered by these students was more extensive and the results more satisfactory than with any previous class. Is it too much to believe that these same students will do equally meritorious work in medicine and surgery?

I must take this opportunity of thanking those members of the various classes who have worked so conscientiously and patiently with me, and to express my gratitude to my able assistants who have taken many burdens from the work. Especially do I feel indebted to my friend and colleague Professor Bayard Holmes, whose energy and perseverance have inaugurated this new work in medical education in the face of many obstacles, and whose constant encouragement has helped me through many difficulties.

The New York Medical Journal.

A WEEKLY REVIEW OF MEDICINE.

EDITED BY

FRANK P. FOSTER, M.D.

THE PHYSICIAN who would keep abreast with the advances in medical science must read a *live* weekly medical journal, in which scientific facts are presented in a clear manner; one for which the articles are written by men of learning, and by those who are good and accurate observers; a journal that is stripped of every feature irrelevant to medical science, and gives evidence of being carefully and conscientiously edited; one that bears upon every page the stamp of desire to elevate the standard of the profession of medicine. Such a journal fulfills its mission—that of educator—to the highest degree, for not only does it inform its readers of all that is new in theory and practice, but, by means of its correct editing, instructs them in the very important yet much-neglected art of expressing their thoughts and ideas in a clear and correct manner. Too much stress can not be laid upon this feature, so utterly ignored by the “average” medical periodical.

Without making invidious comparisons, it can be truthfully stated that no medical journal in this country occupies the place, in these particulars, that is held by THE NEW YORK MEDICAL JOURNAL. No other journal is edited with the care that is bestowed on this; none contains articles of such high scientific value, coming as they do from the pens of the brightest and most learned medical men of America. A glance at the list of contributors to any volume, or an examination of any issue of the JOURNAL, will attest the truth of these statements. It is a journal for the masses of the profession, for the country as well as for the city practitioner; it covers the entire range of medicine and surgery. A very important feature of the JOURNAL is the number and character of its illustrations, which are unequaled by those of any other journal in the world. They appear in frequent issues, whenever called for by the article which they accompany, and no expense is spared to make them of superior excellence.

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